mechanical force expended by the atoms in falling towards one another, which determines the intensity of the current, and, consequently, the quantity of heat evolved; so that we have a simple hypothesis by which we may explain why heat is evolved so freely in the combination of gases, and by which indeed we may account 'latent heat' as a mechanical power prepared for action as a watch-spring is when wound up. Suppose, for the sake of illustration, that 8 lbs. of oxygen and 1 lb. of hydrogen were presented to one another in the gaseous state, and then exploded; the heat evolved would be about 1° F. in 60,000 lbs. of water, indicating a mechanical force expended in the combination equal to a weight of about 50,000,000 lbs. raised to the height of one foot. Now if the oxygen and hydrogen could be presented to each other in a liquid state, the heat of combination would be less than before, because the atoms in combining would fall through less space." No words of mine are needed to point out the commanding grasp of molecular physics, in their relation to the mechanical theory of heat, implied by this statement.

Perfectly assured of the importance of the principle which his experiments aimed at establishing, Mr. Joule did not rest content with results presenting such discrepancies as those above referred to. He resorted in 1844 to entirely new methods, and made elaborate experiments on the thermal changes produced in air during its expansion: firstly, against a pressure, and therefore performing work; secondly, against no pressure, and therefore performing no work. He thus established anew the relation between the heat consumed and the work done. From five different series of experiments he deduced five different mechanical equivalents; the agreement between them being far greater than that attained in his first experiments. The mean of them was 802 foot-pounds. From experiments with water agitated by a paddle-wheel, he deduced, in 1845, an equivalent of 890 foot-pounds. In 1847 he again operated upon water and sperm-oil, agitated them by a paddle-wheel, determined their elevation of temperature, and the mechanical power which produced it. From the one he derived an equivalent of 781·5 foot-pounds; from the other an equivalent of 782·1 foot-pounds. The mean of these two very close determinations is 781·8 foot-pounds.

At this time the labours of the previous ten years had made Mr. Joule completely master of the conditions essential to accuracy and success. Bringing his ripened experience to bear upon the subject, he executed in 1849 a series of 40 experiments on the friction of water, 50 experiments on the friction of mercury, and 20 experiments on the friction of plates of cast-iron. He deduced from these experiments our present mechanical equivalent of heat, justly recognised all over the world as "Joule's equivalent."

There are labours so great and so pregnant in consequences, that they are most highly praised when they are most simply stated. Such are the labours of Mr. Joule. They constitute the experimental foundation of a principle of incalculable moment, not only to the practice, but still more to the philosophy of Science. Since the days of Newton, nothing more important than the theory of which Mr. Joule is the experimental demonstrator has been enunciated.

I have omitted all reference to the numerous minor papers with which Mr. Joule has enriched scientific literature. Nor have I alluded to the important investigations which he has conducted jointly with Sir William Thomson. But sufficient, I think, has been here said to show that, in conferring upon Mr. Joule the highest honour of the Royal Society, the Council paid to genius not only a well-won tribute, but one which had been fairly earned twenty years previously.*

Comparing this brief history with that of the Copley Medalist of 1871, the differentiating influence of "environment" on two minds of similar natural cast and endowment comes up in an instructive manner. Withdrawn from mechanical appliances, Mayer fell back upon reflection, selecting with marvellous sagacity from existing physical data the single result on which could be founded a calculation of the mechanical equivalent of heat. In the midst of mechanical appliances, Joule resorted to experiment, and laid the broad and firm foundation which has secured for the mechanical theory the acceptance it now enjoys. A great portion of Joule's time was occupied in actual manipulation; freed from this, Mayer had time to follow the theory into its most abstruse and impressive applications. With their places reversed, however, Joule might have become Mayer, and Mayer might have become Joule.

JOHN TYNDALL

THE BROWN INSTITUTION

In 1852 a large sum of money was bequeathed by the late Mr. Thomas Brown to the University of London for the purpose of "founding and upholding" an Institution for "investigating, studying, and if possible endeavouring to cure" the diseases and injuries of animals useful to man. The sum was to be allowed to accumulate for a limited period, at the end of which the principal and interest were to be applied in the manner directed. And it was provided that in case the University should fail to carry out the trust imposed upon it within nineteen years after the testator's death, the whole sum with the accumulations should be transferred to the University of Dublin, to be applied for the endowment of certain philological professorships. The will contains various directions for the administration of the proposed Institution. The most important are those which relate to the appointment of a Committee of Management and of a Professor. The committee must be appointed by the governing body of the University, and must consist either of members of the Senate or of other persons, members of the medical profession. As regards the qualifications of the professor nothing is said. He must be appointed by the University, must give a course of lectures annually, and must have a residence adjacent to the Institution.

The nineteen years have now almost expired. In pursuance of the testator's directions, the "Brown Institution" has just been opened. Last summer a large plot of freehold land was acquired by the University in the Wandsworth Road, close to the goods station of the South-

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* Had I found it in time, this notice should have preceded that of the Copley Medalist of 1871.

Western Railway. On this ground a Hospital for Animals has been built, consisting of stables for the reception of the larger quadrupeds, and of houses of various descriptions for those of a smaller size. All of these buildings are constructed in the best style, with a view to the well-being of the creatures they are destined to contain, being thoroughly drained, paved, and ventilated, and warmed with hot-water pipes. Adjoining them there is a spacious exercise ground.

As many of our readers already know, the Senate have placed the Institution under the management of Dr. Burdon Sanderson, of University College, London, who, as Professor, will, in future, deliver the annual course of lectures.

If the scope and purpose of the Brown Institution were limited to the care and cure of diseased animals, its establishment would scarcely be worthy of record in the pages of NATURE, for, however desirable it may be that the animals that serve us should be kindly and skilfully treated when they are sick, the object has so remote a relation to the promotion of physical science that our readers could not be expected to take any special interest in it. But, happily alike for humanity and for science, the late Mr. Brown showed by his selection of persons to be entrusted with the carrying out of his intentions, by the instructions contained in his will for their guidance, and by the terms in which he defined the purposes of the proposed Institution—placing study and investigation first, cure afterwards—that he was not actuated by a mere sentimental sympathy for the lower animals as such, but that he desired, by promoting the scientific study of their diseases, to benefit mankind.

As might have been expected, the Senate of the University of London have not only fulfilled the letter of the testator's dispositions, but have proved by the manner in which they have done so, that they are actuated by the same noble purpose. They have shown this first of all in their selection of a Committee of Directors. What could be a better guarantee for the future good administration of the Institution than the fact that among its directors are to be found such men as Busk, Carpenter, Gull, Paget, Quain, Sharpey, Sibson, and Simon, men eminent as physiologists, pathologists, or clinical teachers; of each of whom it may be said that he has contributed a large proportion to the total amount of work done in his own branch of science in England during the past thirty years. We do not think that it would have been possible, even if their choice had been perfectly unlimited, to have selected persons more fitted for the purpose, whether as regards personal character or scientific attainments.

Under the direction of Dr. Sanderson, a laboratory intended, to quote the terms of the will, "for the study and investigation of disease," has been built on the ground already referred to at Vauxhall, adjoining the hospital for animals. The laboratory consists of four admirably-lighted and spacious working rooms, connected by a corridor. Underneath these are four other rooms, which, although not so lofty, are also well adapted for many kinds of research. In the same building is included a stable for the reception of animals intended to be the subjects of special observation.

In the work of the laboratory the Committee of Direction have most wisely associated with Dr. Sanderson, under the title of Assistant Professor, Dr. E. Klein, whose name is well known as the contributor of valuable articles to Stricker's "Histology," and of several important embryological researches. Well trained as a pupil of Brücke and Stricker in the methods of research, whether physical, chemical, or microscopical, young in years though old in accomplished work, Dr. Klein is singularly fitted for the post. Dr. Sanderson is much to be congratulated in having so able a coadjutor.

It may not be out of place if we attempt to give our readers an idea of the work which we suppose will be done or attempted in the laboratory of the Brown Institution.

The facts on which the science of disease, so far as it may as yet be called a science, is founded, are gathered from two sources, the bedside and the laboratory. In clinical studies the same, or even greater, exactitude is required as in those of the physicist or chemist; but even when they are conducted in the wards of a hospital, the Harveian method of "searching out the secrets of nature by way of experiment," can only be applied under limitations which very materially embarrass the inquiry. The pathologist at the bedside is not in the position of an experimenter, but only in that of a student, who stands by at a greater or less distance, while another, over whom he has no control, performs experiments in his presence, without deigning to explain to him their nature or purpose. The true physician fears to meddle with the processes of which he is the attentive and anxious spectator. Although the more ignorant members of the medical craft—the so-called "practical" men—may sometimes, with the best intentions, experiment on their patients with harmful drugs, such experimentation is repudiated by the man of science.

There are, however, many questions relating to disease, of the most profound importance to the human race, which cannot be solved, and never will be solved, by thus, as it were, standing on one side and watching what goes on at a distance; such questions, for example, as the nature of contagion, and those which relate to the origin and proximate causes of our most common diseases, such as inflammation, fever, and tubercle. The knowledge which has been acquired on these subjects during the last few years has been gained by work done in laboratories. The advantages of this mode of inquiry, as compared with the indirect clinical method, are of two kinds—the one relating to the objects of observation, the other to the means which are at the disposal of the inquirer. In dealing with animals, he is embarrassed by scarcely any of the limitations which render clinical observation so difficult. The very considerations, indeed, which in the case of man, absolutely forbid his entertaining any other purpose excepting that of prolonging life and alleviating pain, not only allow, but encourage him, in the case of animals, to disregard altogether the present suffering for the future benefit. We are clearly justified in profiting by the sufferings of the lower animals for man's sake. We may subject them experimentally to the action of remedies without any immediate view to their being thereby benefited. We may place them under conditions which we know will produce disease, for the purpose of studying the mode of action of those conditions. We have at least as good a right to kill sick animals for the purpose of investigating the anatomical changes produced by disease, as to slaughter healthy animals for food. And even if in the pursuit of our inquiries we are compelled to inflict pain, we are perfectly right in doing so—provided that truths valuable to humanity are to be learnt by it.

The other respect in which the comparative pathologist has an advantage over the clinicist, lies in the choice of means. It is true that during the last few years much progress has been made in the application of instruments of precision to the investigation even of human diseases; but, after all, there are few of those instruments which are really valuable. In the case of animals it is entirely different. The microscope may be applied to the investigation of tissues unaltered by those changes which speedily follow the extinction of life. The measurement of the temperature of the body, whether with relation to the changes which it undergoes in disease, or to the differences between diseased and healthy parts, can be performed in animals with all the exactitude which such investigations require—in man such exactitude is impossible, because the conditions of observation cannot be controlled. Instruments of precision may be used for the investigation of the changes which disease produces in the mechanical functions of respiration and circulation, which, for reasons already adverted to, could not be applied in the sick room, or in the wards of a hospital—and if they were applied, would yield no satisfactory results.

Again, in animals it is possible to apply the ordinary methods of chemistry to investigate the modifications produced by disease in the process of nutrition; whereas in man this is attended with such insuperable difficulties, that it may be regarded as impossible.

Many other similar examples might be mentioned; but these may serve to explain the way in which we hope to see the new laboratory at Vauxhall brought into relation with the hospital for sick animals. Believing that the study of pathology, like that of physiology, of which it forms part, can only be successfully prosecuted by observing the operation of chemical and physical laws in the living diseased body, and applying the same methods as are used by the chemist and physicist to their investigation, and that the more this principle is acted on, the more rapid and solid will be the progress made, we regard the establishment of the Brown Institution as an important step in the right direction. We should have been still better pleased if it had been a laboratory of physiology, for this ought to have preceded the other. We think it, however, not unlikely that it may, by setting an example of good work, exercise a considerable indirect influence in the promotion of physiological studies in this country.

We must not omit to mention that although the laboratory is intended for research rather than for instruction, it will be open to those who may wish to engage on their own account in scientific inquiries. The only condition imposed by the directors on those who desire admission to the laboratory as workers, is the possession of "previous scientific training." Each worker will have to defray the expenses of material, but no other payment will be required of him. It is understood that the laboratory will be opened on the 1st of January, 1872.

FOREIGN YEAR-BOOKS

Jahrbuch der Erfindungen. Herausgegeben von H. Hirzel und H. Gretschel. Sechster Jahrgang. (Leipzig: Quandt und Händel; London: Williams and Norgate, 1870; pp. 472.)

THE sixth volume of this series fully sustains the high character achieved by its predecessors. Astronomy, physics and meteorology, mechanics and mechanical technology, and chemistry and chemical technology form the subjects of the respective chapters.

We cannot open any part of the work without observing the care with which it is edited. We shall select for special notice the latter part of the chapter on chemistry, which treats of organic compounds, beginning with the following paragraph upon the products of oxidation of paraffin. After describing the recent improvements introduced by Hübner in the preparation of this substance from coal-tar, and in its mode of purification, and noticing its remarkable stability (it being unaffected by concentrated hydrochloric or sulphuric acids, and by the alkalies), the reporters state that there are certain oxidising agents, and especially chromic and nitric acids, which it is unable to resist. Gill and Meusel have studied the action of these reagents on paraffin, and have arrived at the following results:—

"The paraffin in common use fuses at 56° C., and by repeated crystallisation from sulphide of carbon the fusing point may be raised to 60° and upwards. If we boil from 300 to 500 grammes of pure paraffin with 120 grs. of bichromate of potash, and 180 grs. with sulphuric acid diluted with twice its volume of water for three or four days in a glass retort till the chromic acid is completely reduced to chrome-oxide, acetic acid and other acids of the same series, and principally cerotic acid, are formed; the latter being a white solid substance that does not fuse at a lower point than 78° C., and also occurs as a main constituent of bees'-wax. If we boil paraffin continuously with five or six times its volume of nitric acid of 1·3 sp. gr., which has been previously diluted with 1½ times its volume of water, we likewise obtain cerotic acid, in addition to acetic, butyric, valerianic, and succinic acids, and other products" (p. 261).

Passing over a section on "Fats, fatty oils, and allied substances, and the products of their decomposition," in which is a notice of the explosive compounds derived from glycerine, we come to one treating of "Resins," in which there is a notice of Puscher's interesting and highly-practical communication on shellac-ammonia solutions. Perhaps the most valuable of the applications of these solutions is their property of dissolving certain of the aniline colours, as aniline green, aniline yellow, and fuchsine.

The organic non-nitrogenous acids, the carbo-hydrates, alcohol and its products, the albuminous bodies and their allies, newly-discovered organic bases, pigments and pigment-yielding bodies, both natural and artificial, nutritious matters, and disinfectants, are all duly considered. The report on artificial pigments is especially deserving of commendation. It consists of nearly fifty pages full of practical matter, and, taken in conjunction with a previous report that appeared in the second volume (for 1866), forms the most complete summary of this important department of practical chemistry, that, taking its limits into consideration, we are acquainted with.

As usual the volume concludes with a necrology for the past year.